Joining of Al_2O_3 to SUS 304 with Ti Foil†

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Ceramics have received considerable interests in practical application because of their superior heat- and corrosion-resistance. The inferior workability arisen from its high hardness and embrittlement requires the joining of ceramics to metals. Several investigations on ceramic-metal joining have been reported[1-6]. The joining of alumina to steel was made in slightly oxidizing atmosphere using copper filler, and the joinig of metals to Si_3N_4 with amorphous Cu-Ti and Ni-Ti filler metals. The present paper deals with the joining method of alumina to SUS 304 stainless steel using titanium foil.

Alumina (99.6 wt% Al_2O_3) of 6 mm diameter and 5 mm thick and SUS 304 stainless steel of 6 mm diameter and 5 mm thick were used to make a butt joint. The high purity titanium foil 6 mm diameter and 0.5 mm thick (99.6 wt% Ti) was inserted between alumina and SUS 304.

Figure 1 shows the construction for joining. The joining was done under the joining condition of 1400°C for 30 min under 50 kg/cm^2 in vacuum condition of 1 X 10^{-6} torr using a high frequency heating. The heating rate is about 50°C/min up to the joining temperature. The microstructural analyses were performed using energy dispersive X-ray microanalysis (EDX) and scanning electron microscopy (SEM).

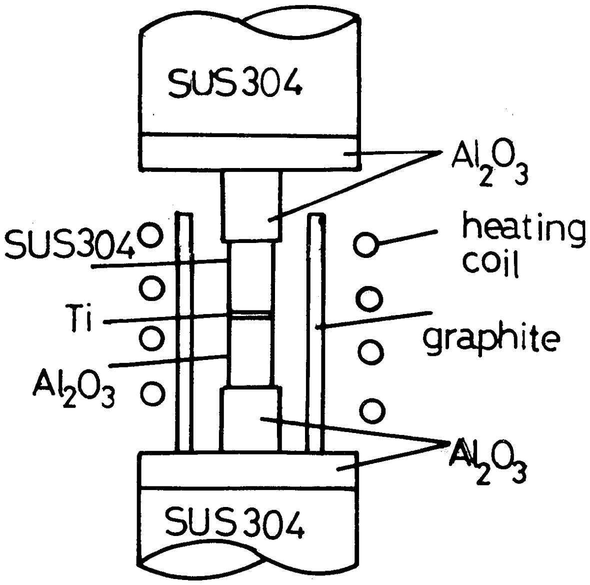

Fig. 1 Schematic Construction for joining.

The joining of alumina to SUS 304 was made without cracks in alumina in **Figs.** 2 and 3. **Figure** 2 shows the analyses of Fe and Ti of Al_2O_3/SUS 304 joint. Titanium changes from the plate structure to the solidified structure. Titanium rich structure is formed at the intermediate layer between SUS 304 and alumina. Since titanium rich alloy with 68 at% Ti content in Ti-Fe system[7] shows the Ti-FeTi eutectic reaction at 1085°C, the titanium rich structure in the Al_2O_3/SUS 304 joint may be formed by the reaction of Ti-FeTi phases. **Figure 3** shows the SEM

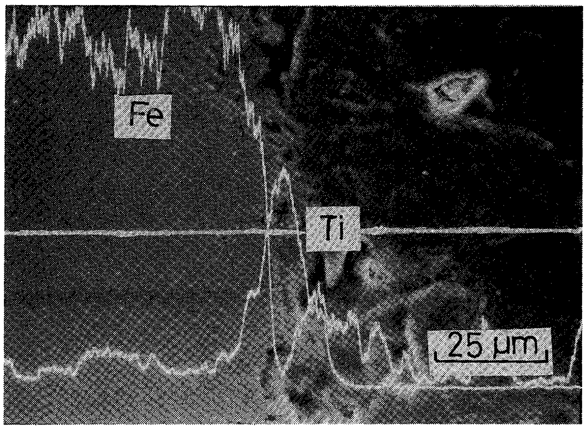

Fig. 2 SEM microstructure and line analyses of Ti and Fe of Al_2O_3/SUS 304 joint joined at 1400°C for 30 min under 50 kg/cm^2.

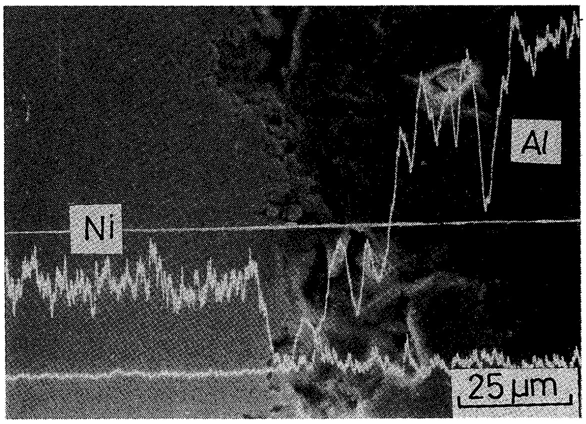

Fig. 3 SEM microstructure and line analyses of Ni and Al of Al_2O_3/SUS 304 joint joined at 1400°C for 30 min under 50 kg/cm^2.

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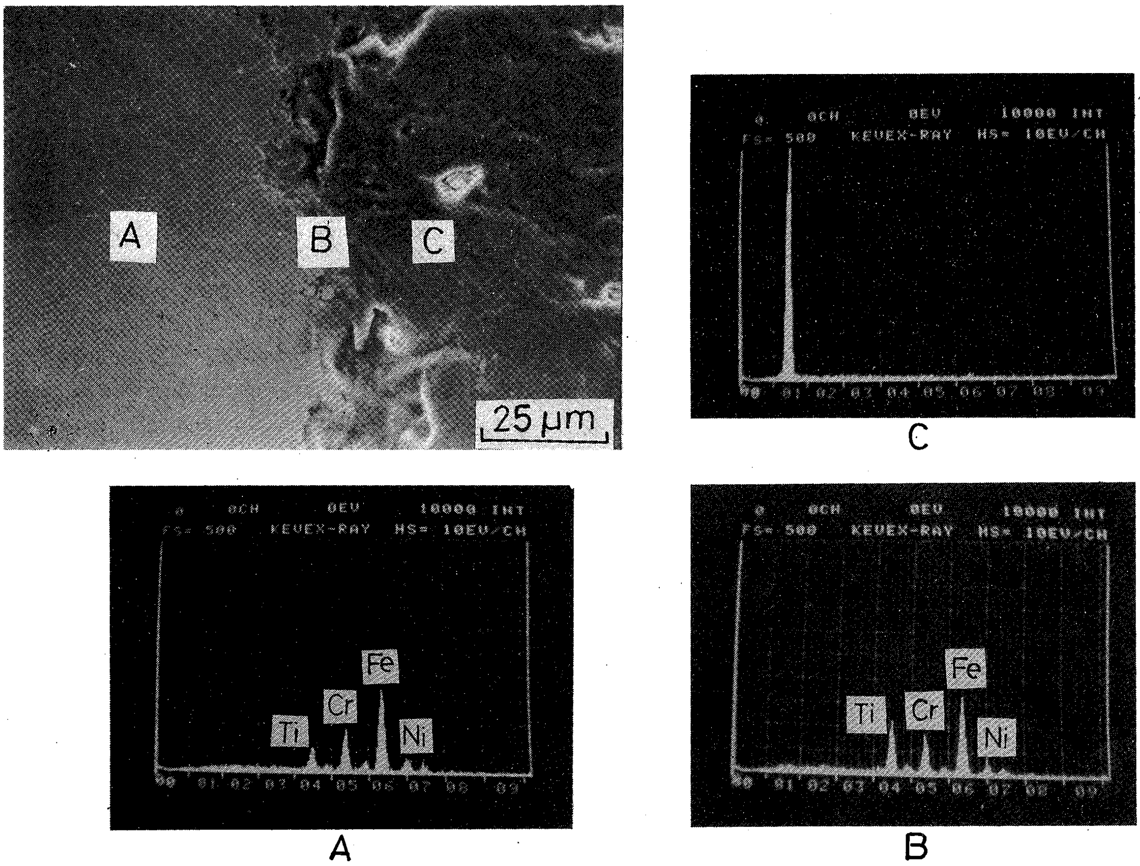

Fig. 4 EDX spot analyses of A, B and C in Al_2O_3/SUS 304 joint joined at 1400°C for 30 min under 50 kg/cm^2.

microstructure and line analyses Ni and Al of Al_2O_3/ SUS 304 joint. The eutectic structure contains chromium and nickel as shown in EDX spot analyses in B of Fig. 4. Titanium diffuses into the matrix of SUS 304, as shown in EDX spot analyses in A of **Fig. 4**.

In conclusion alumina and SUS 304 stainless steel are soundly joined by forming the titanium rich eutectic liquid during joining.

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